Asynchronous Counters

Lecture Overview

- Classifications of Counters
- Definitions
- Asynchronous Counter…
  - J – K Flip Flops
  - D Flip Flops
  - Up Counters
  - Down Counters
  - Truncated Counters

Classifications of Counters

Asynchronous Counters

- Only the first flip-flop is clocked by an external clock. All subsequent flip-flops are clocked by the output of the preceding flip-flop.
- Asynchronous counters are slower than synchronous counters because of the delay in the transmission of the pulses from flip-flop to flip-flop.
- Asynchronous counters are also called *ripple-counters* because of the way the clock pulse ripples it way through the flip-flops.

Classifications of Counters

Synchronous Counters

- All flip-flops are clocked simultaneously by an external clock.
- Synchronous counters are faster than asynchronous counters because of the simultaneous clocking.
- Synchronous counters are an example of *state machine* design because they have a set of states and a set of transition rules for moving between those states after each clocked event.

States / Modulus / Flip-Flops

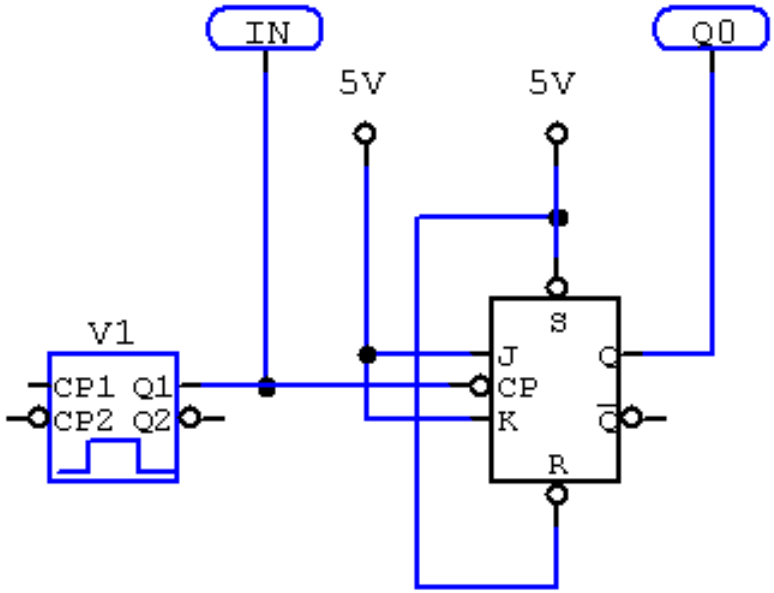
- The number of flip-flops determines the count limit or number of states.

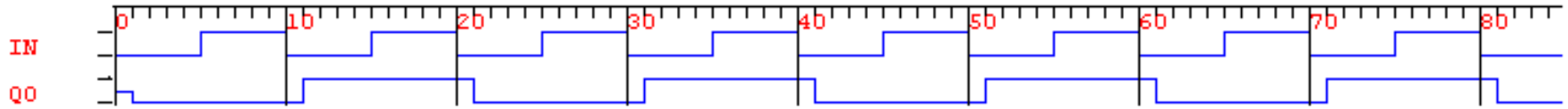
  (STATES = $2^{\#\ of\ flip\ flops}$)

- The number of states used is called the *MODULUS.*

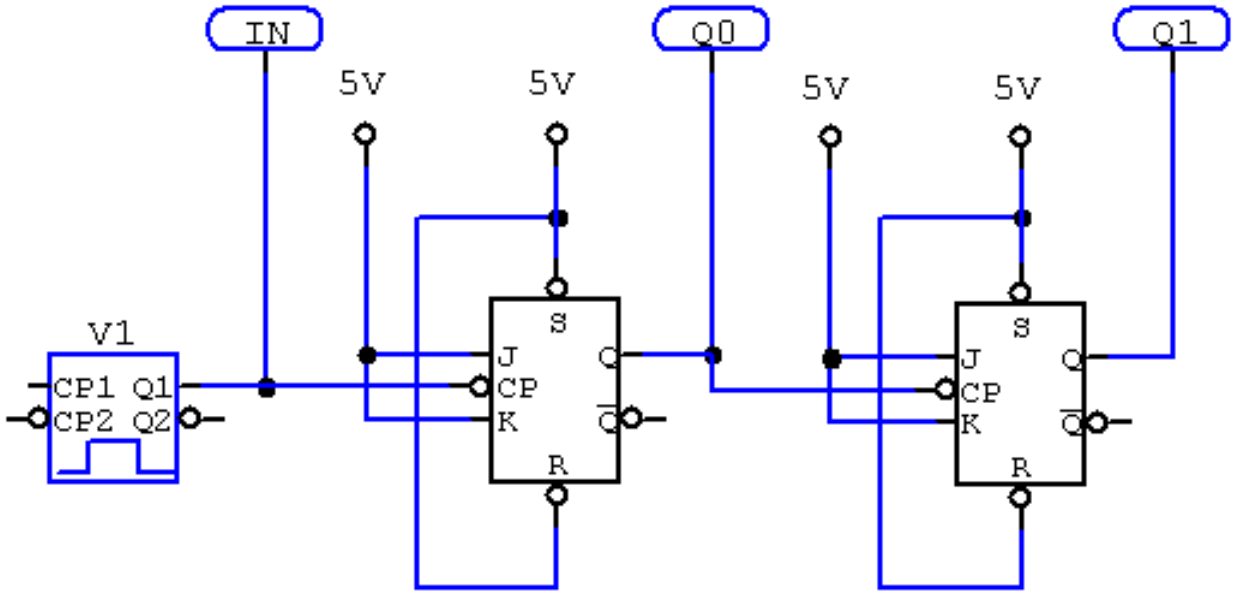
- For example, a Modulus-12 counter would count from 0 (0000) to 11 (1011) and requires four flip-flops (16 states - 12 used).

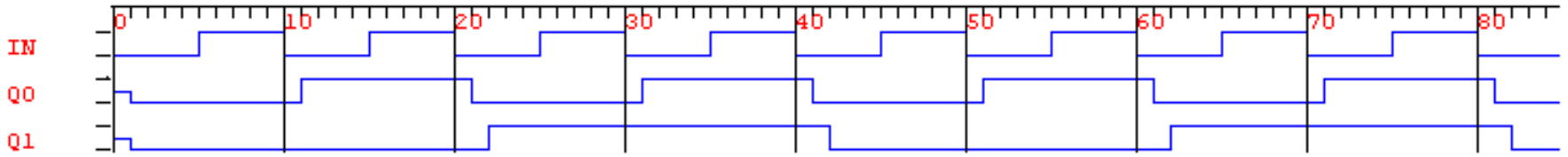
1 Bit Asynch-Counter / Modulus 2



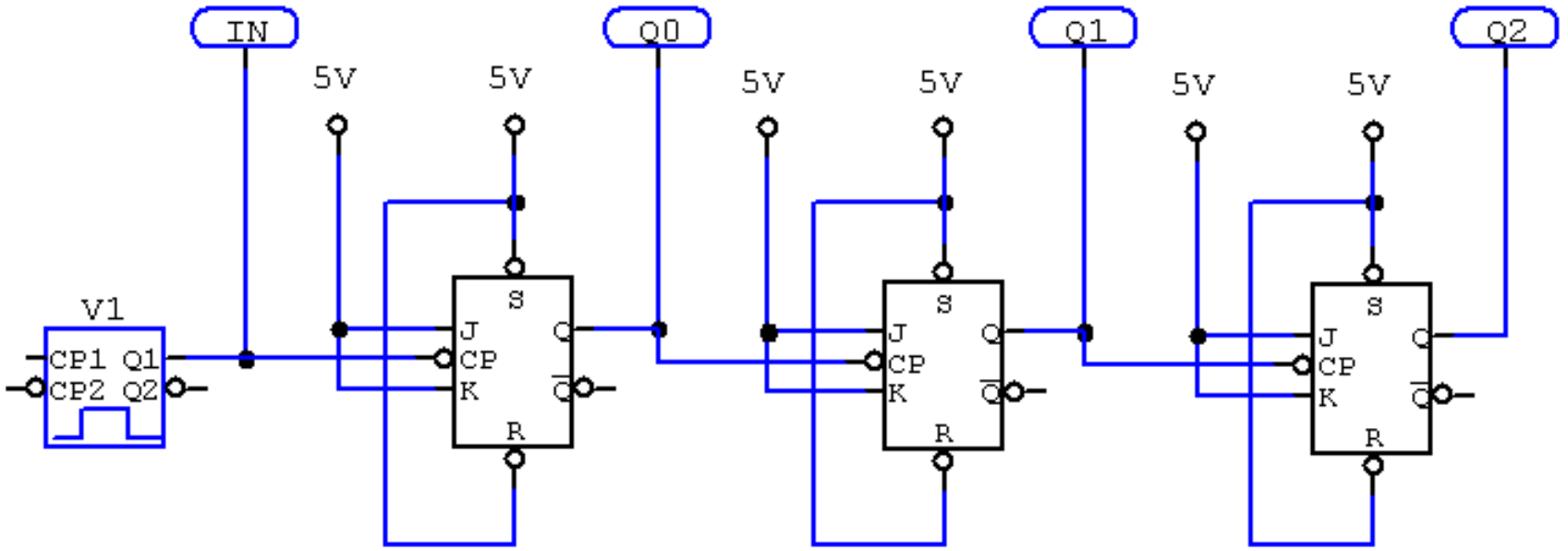


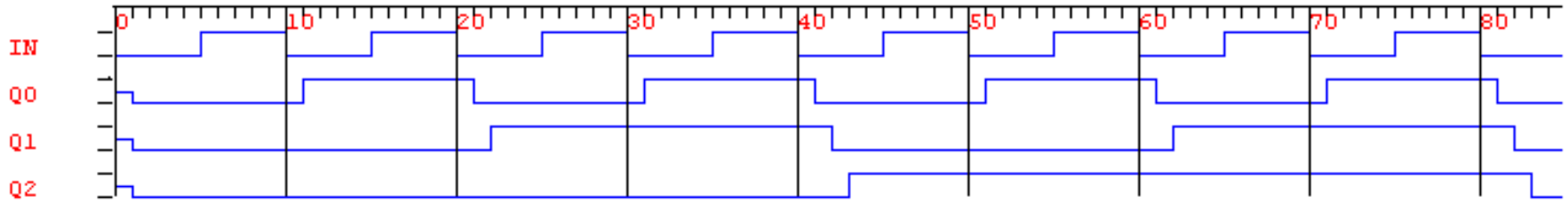
2 Bit Asynch-Counter / Modulus 4



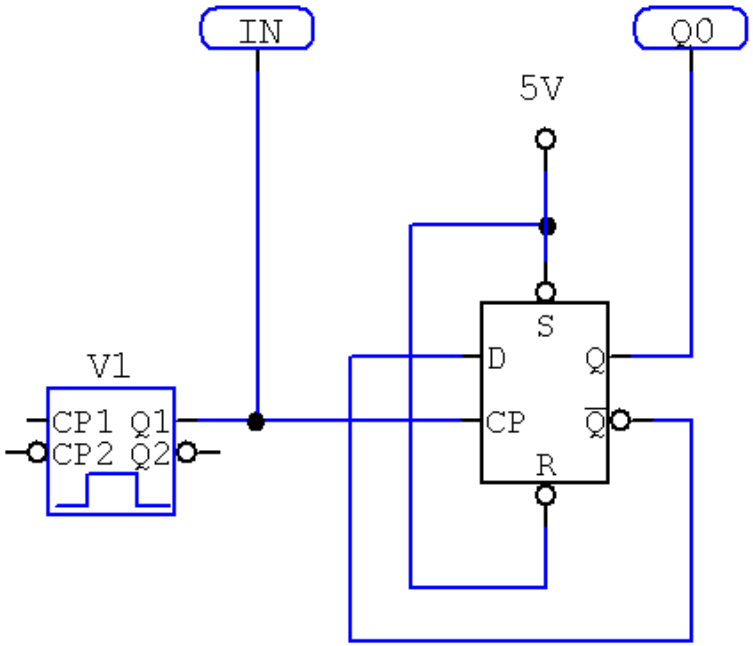


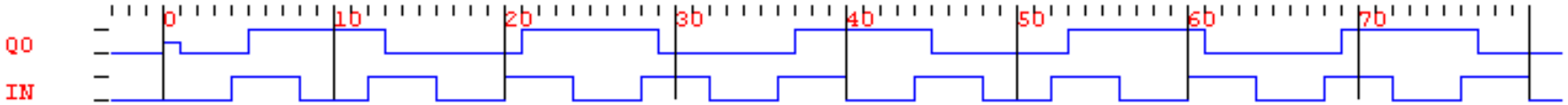
3 Bit Asynch-Counter / Modulus 8





D Flip-Flop… Nothing Special About J-K

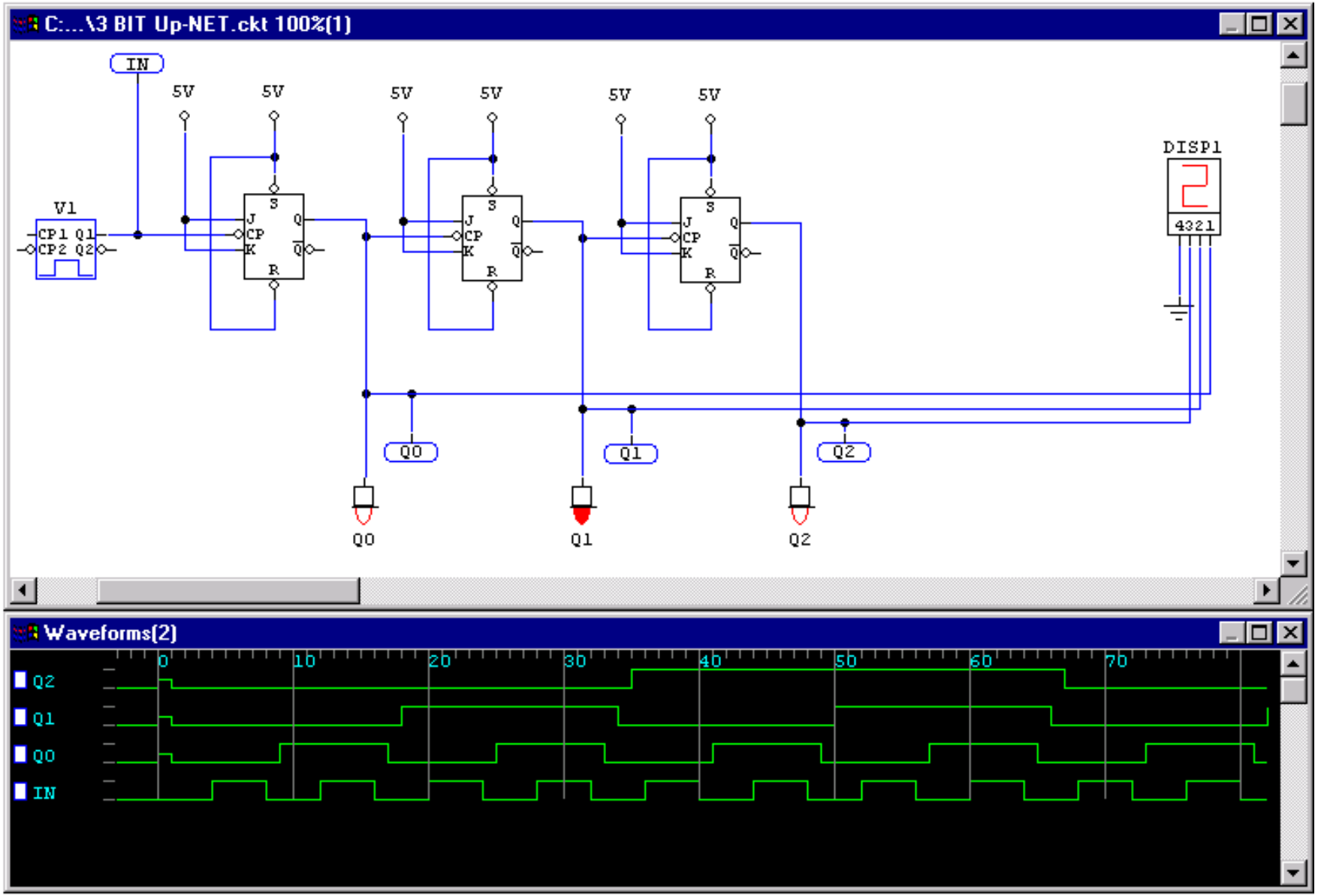




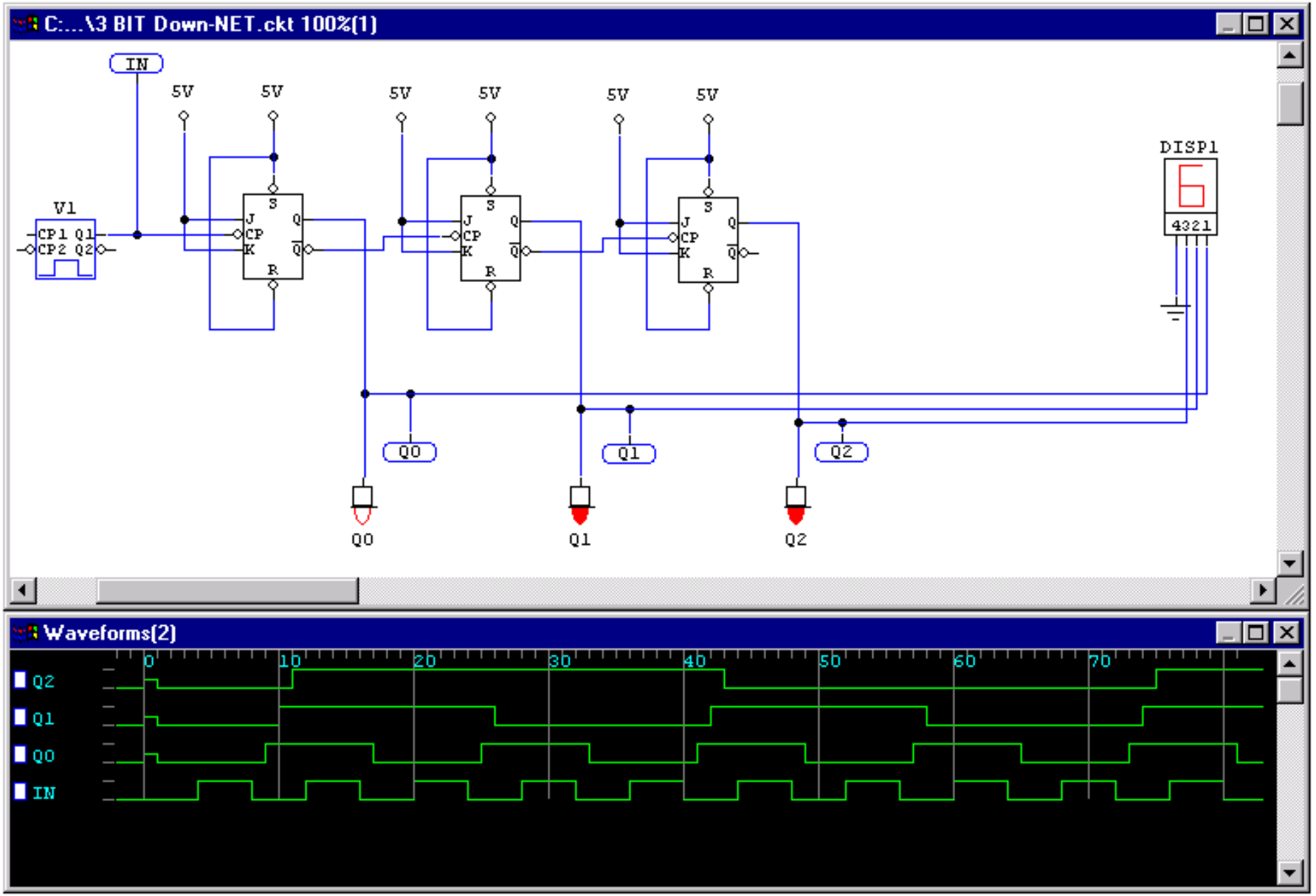
Six Examples

1. Modulus 4 Up Counter with Negative Edge Triggered Flip-Flops
2. Modulus 4 Down Counter with Negative Edge Triggered Flip-Flops
3. Modulus 4 Up Counter with Positive Edge Triggered Flip-Flops
4. Modulus 4 Down Counter with Positive Edge Triggered Flip-Flops
5. Truncated Counter
6. Counter Design

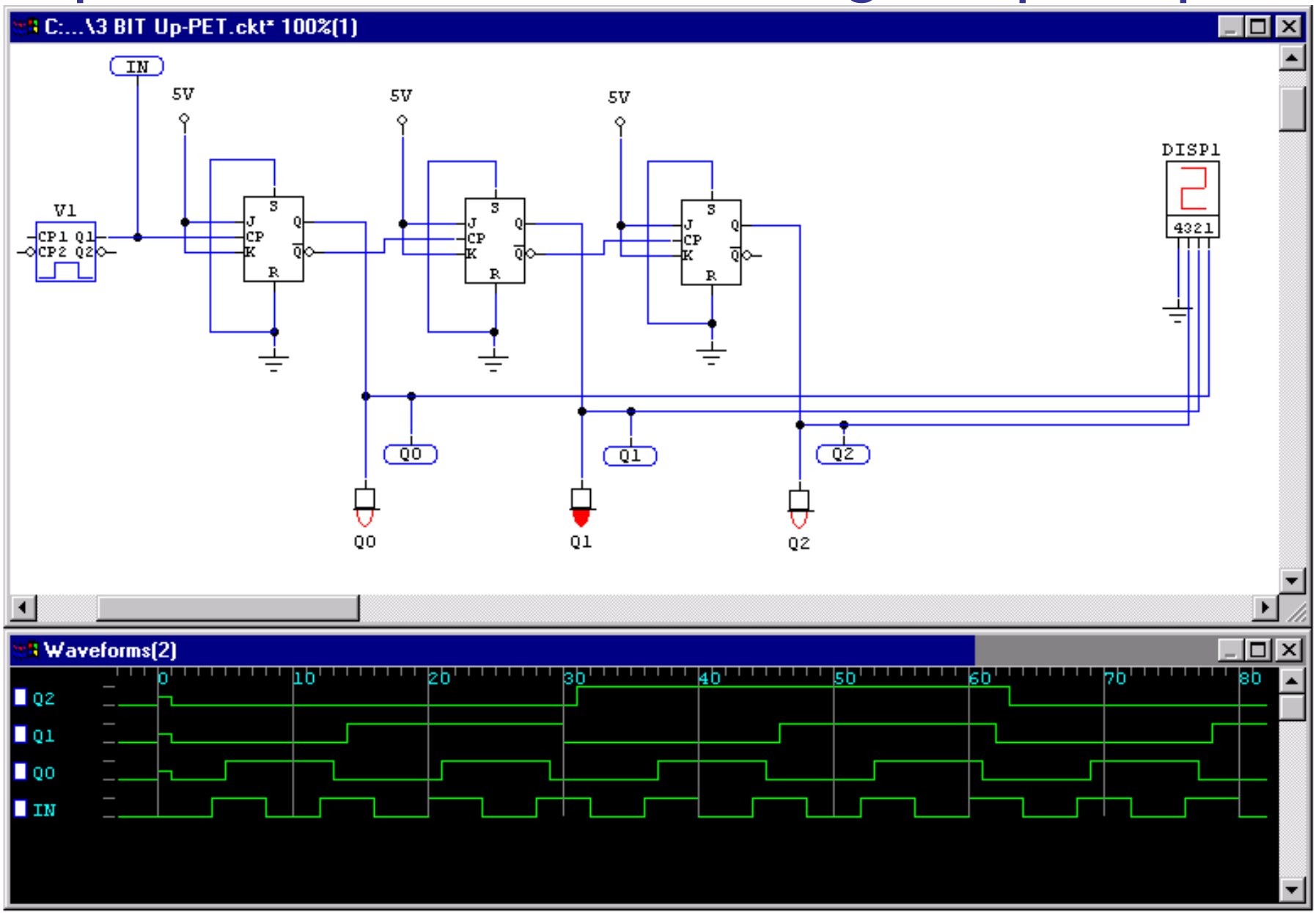
Up Counter w/ Negative Edge Flip-Flops



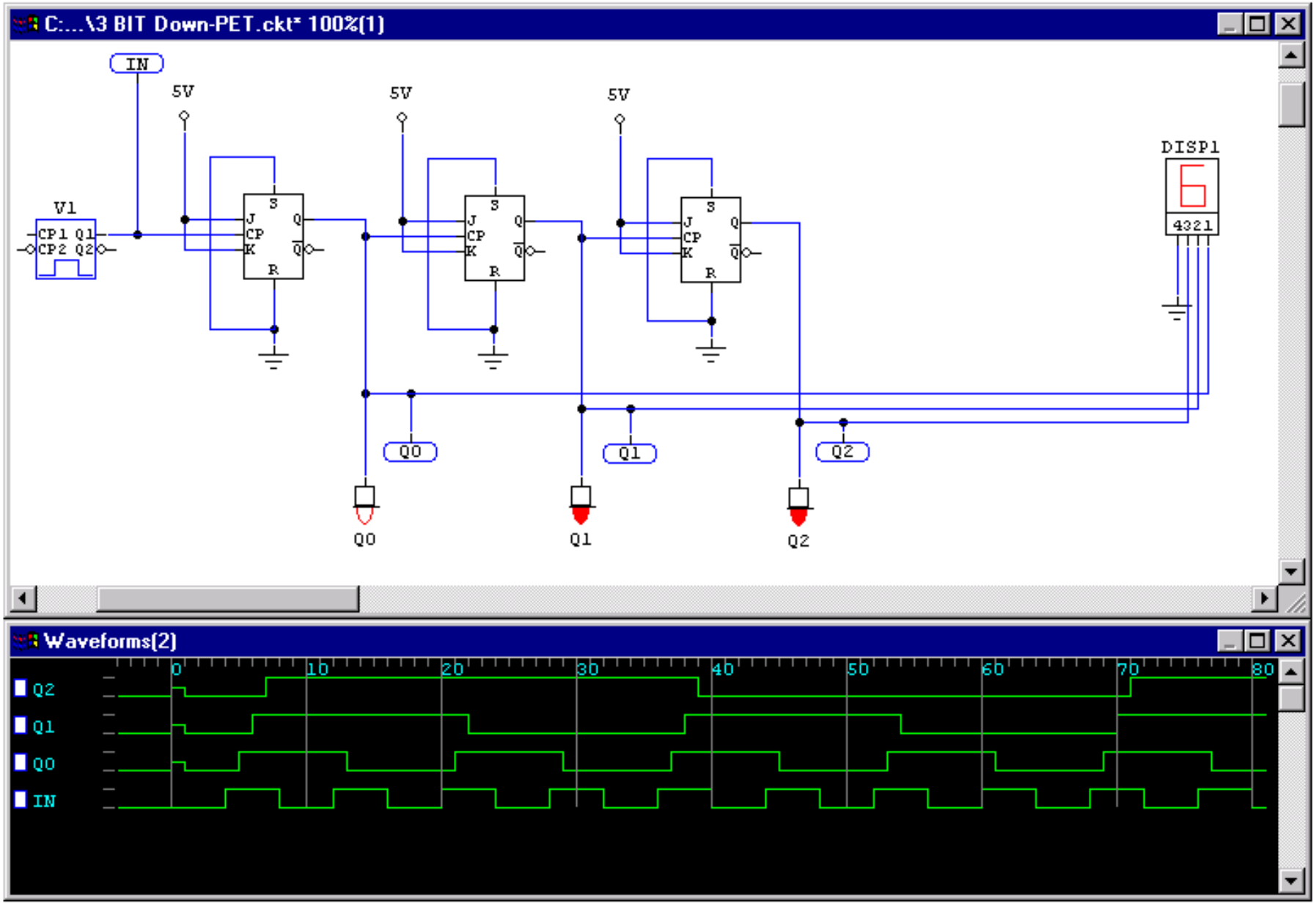
Down Counter w/ Negative Edge Flip-Flops



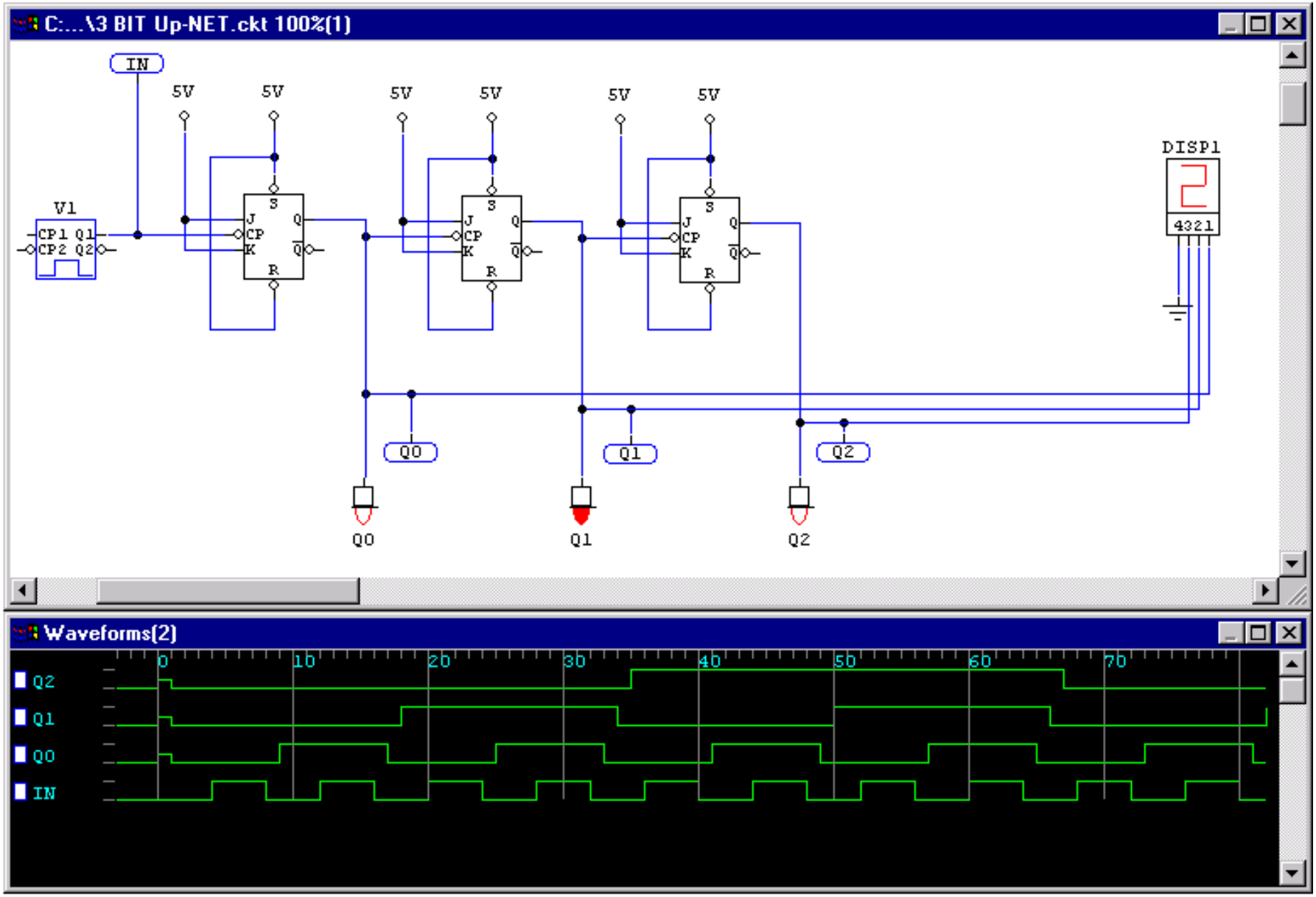
Up Counter w/ Positive Edge Flip-Flops



Down Counter w/ Positive Edge Flip-Flops



Truncating the Count… Modulus 6



Modulus-6 Counter